E/CONF.39/A/142
18 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.3.2.1

Japan

DISCHARGE MEASUREMENTS BY USING A FLOAT

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DISCHARGE MEASUREMENTS BY USING A FLOAT

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I. ADVANTAGES AND DISADVANTAGES OF FLOAT MEASUREMENT

1. Japan is a mountainous country where rivers are so steep in gradient that they flow at a high velocity, carrying away huge quantities of matter during flood time. For this reason the Price current meter is not suitable for velocity measurements during flood time, and a float is used at almost all gauging stations. Fortunately bamboo is so easily available everywhere in Japan that a bamboo float as shown in Figure III is used for this purpose in most instances.

2. Close attention should be paid to various points where the measurement of velocity is made by using a bamboo float, taking into account the following advantages of the float :

(a) Immerging a float in a stream is easy where there is a bridge
(b) A simple immerging device is good enough when gauging at a site where the river is narrow in width
(c) A velocity close enough to mean velocity is obtainable in gauging with a long float.

3. The flow velocity gauged with a float is a mean value for a certain distance along a river. Accordingly the conditions of the section may be a matter of discussion.

(a) It would be impossible to find a straight course of stream where the cross section is in a constant or in a uniform variation all the way through the course.
(b) The flow down course of a float as well would often be not perpendicular to the cross section. In such a case the area to be assigned to the float is hard to estimate for the calculation of flow velocity.
(c) In flow velocity measurement by means of a float the cross section of a stream is not measured at the same time. The cross section surveyed after or before a flood is applied to a flood discharge calculation . It is considerably different from its value during a flood. As a result, some error would be inevitable in such a calculation.

4. We do not think that flow measurement by means of a float is satisfactory for flood flow observation. The author and his associates are developing a new type of current meter for depth and velocity, as show in Figure IV, which gives precise flood discharge. This new meter is expected to be completed soon.

II. ANALYSIS OF REDUCTION COEFFICIENT

5. Theoretical analysis

There have been two typical papers published in this country on the motion of a float in a stream as quoted hereafter.

(a) Mononobe's reduction formula :—

Based upon the assumption that a float placed in a stream behaves relative motion with the flow, applying Bazin and Humphrey's curvilineal formula for flow velocity distribution, a correlation equation was introduced to find the flow down velocity of float. The reduction coefficient α denoting the ratio of the mean flow velocity of flow distribution curve to the flow down velocity of a float can be represented by the following formula.

$$\alpha = 1 - \frac{12}{c}\left\{1 - 2.5(n-0.3)^2\right\}$$

when

c is Chezy's velocity coefficient and n is the ratio of the depth of the immersion of a float to the depth of water.

(b) Aki's reduction formula :—

Based on the assumption that a float placed in a stream follows just the same movement as current, solving a equation of motion with Kozeny's turbulent coefficient put in it, a curvilineal equation of current velocity distribution was introduced. The reduction coefficient α of float is represented by the following formula.

$$\alpha = \frac{C}{C + \frac{20}{3} - \frac{20}{3}n} \qquad (a = 0)$$

$$= \frac{C}{C + \frac{1}{3} + 2n - \frac{20}{3}n^2} \qquad (a = 0.1)$$

$$= \frac{C}{C + \frac{4}{3} + 4n - \frac{20}{3}n^2} \qquad (a = 0.2)$$

$$= \frac{C}{C + \frac{7}{3} + 6n - \frac{20}{3}n^2} \qquad (a = 0.3)$$

when

a is the position of maximum velocity from surface.

6. Experimental analysis.

(a) Velocity distribution :—

The velocity distribution of a stream during flood time was observed by means of a current meter for depth and velocity as mentioned above. The meter has a device for automatically recording velocity distribution with it gently immerged up to river bed from water surface. Fig I shows the flow velocity distribution as recorded at a gauging station on the stream with 0.8 m water depth and 3 m/sec mean velocity during a small flood. This gauging station has some 1/300 grade of stream and a river bed made of coarse gravel and sand. In contrast to such test findings the flow velocity distribution in a concrete channel is far more uniform.

(b) Shape of river bed :—

The shape of river bed at a certain cross section of a stream was surveyed intermittently during a flood time. Depth of water was measured with a 100 kg weight immerged from a cable car. Fig. II shows that the river bed is much scoured during flood time.

III. SIMPLIFIED REDUCTION COEFFICIENT

7. The gauging of flood flow in this country is carried out in such circumstances where floats have to be applied for gauging flow velocity during a flood. In order to help ease the preparation and work of gauging and flow calculation, it was found effective that such floats be limited to several types as to fix the reduction coefficients of flow velocity to a constant value. The applicable water depths, the length of floats and the reduction coefficients are in the relation as shown in the Table 1.

TABLE 1.

Applicable water depth (m)	Length of float to be used (m)	Reduction coefficient
- 0.7	surface float	0.85
0.7 - 1.3	0.5	0.88
1.3 - 2.6	1.0	0.91

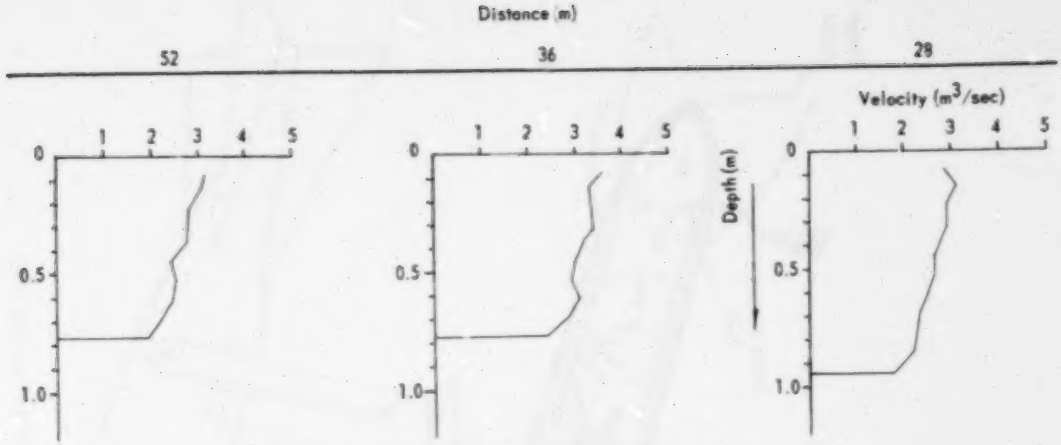

Fig. I - Example of flow velocity distribution

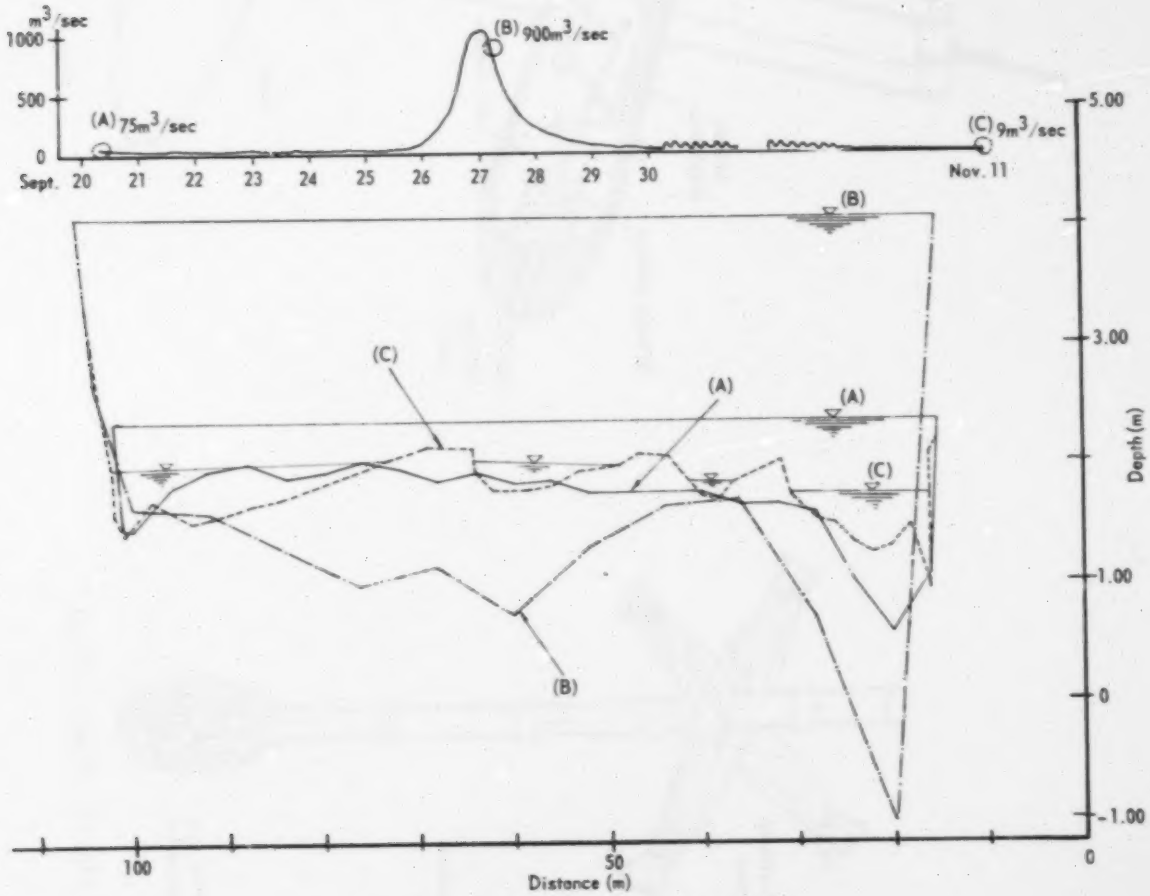

Fig. II - Example of scouring of river bed

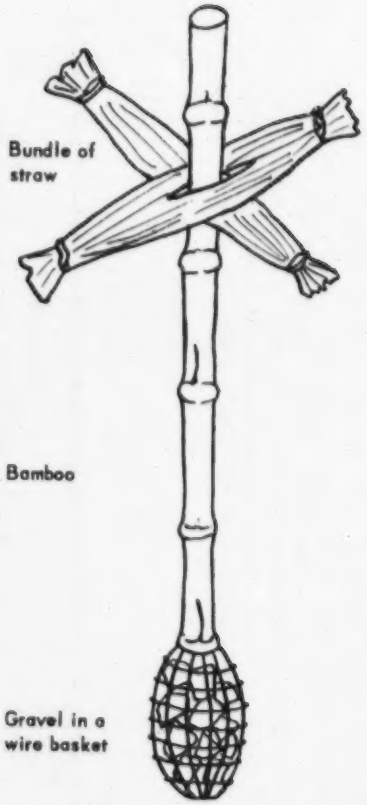

Fig. III - Bamboo Float

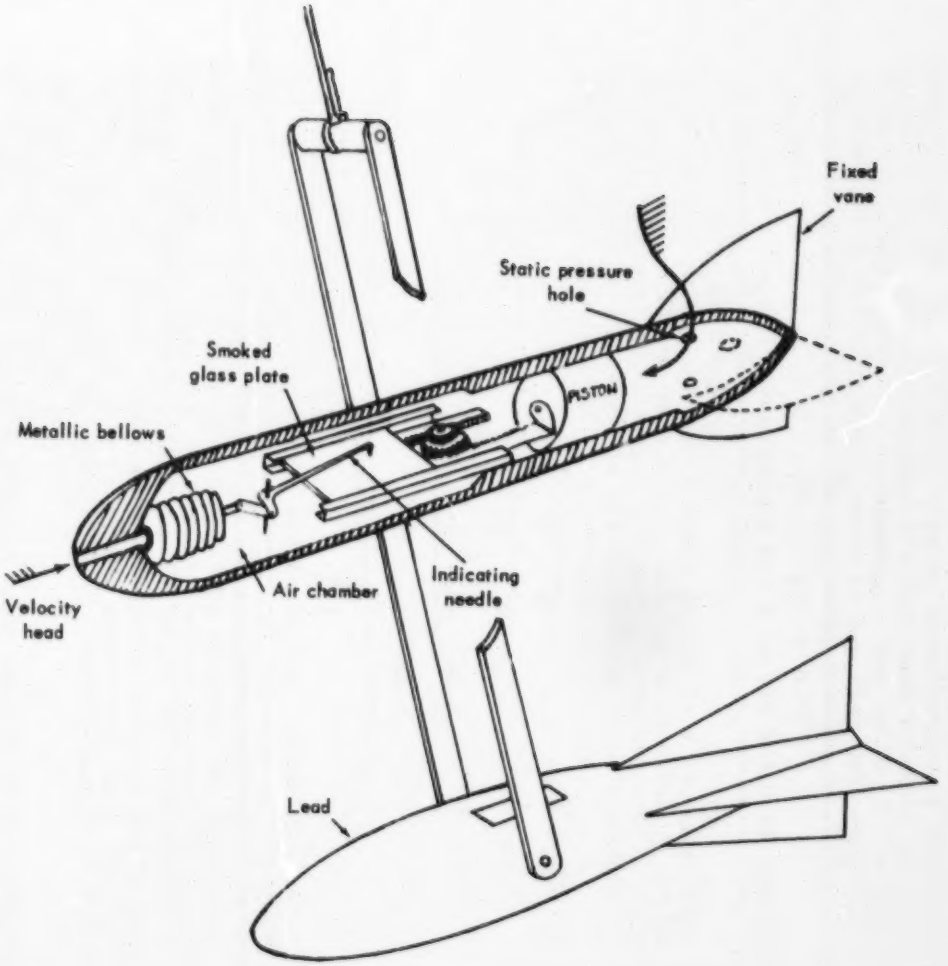

Fig. IV - New currentmeter

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